Brief on Appeal #17
E. Burns 10/09/02

CUSTOMER NO. 020991

PATENT
PD-980034

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: Donald C. D. Chang et al.

Date: October 2, 2002

Serial No. 09/497,865

Group Art Unit: 3662

Filed: February 4, 2000

Examiner: G. Issing

For: AN IMPROVED PHASED ARRAY TERMINAL FOR EQUATORIAL SATELLITE CONSTELLATIONS

BRIEF ON APPEAL

Box AF
Commissioner for Patents
Washington, D.C. 20231

Sir:

The following Appeal Brief is submitted pursuant to the Notice of Appeal filed on August 14, 2002, for the above-identified application.

I. Real Party in Interest

The real party in interest in this matter is Hughes Electronics Corporation of El Segundo, California, which is a wholly owned subsidiary of General Motors Corp.

II. Related Appeals and Interferences

There are no other known appeals or interferences which will directly affect or be directly affected by or have bearing on the Board's decision in the pending appeal.

III. Status of the Claims

Claims 1-5 and 7-37 stand rejected in the Final Office Action. A copy of the claims on appeal is attached as an Appendix hereto.

IV. Status of Amendments Filed After Final

There have been no amendments filed subsequent to the final rejection.

V. Summary of the Invention

The present invention relates generally to a low cost, low profile tracking phased array antenna for use on a commercial satellite terminal that is adapted for use with an equatorial satellite constellation system. Various tracking ground terminals exist, which are directed for use and sale in the consumer market. These antennas are typically configured as multi-beam tracking ground terminals, which include arrays with mechanisms for steering beams, such as phase shifters. These arrays further include integrated mechanisms for simultaneously tracking the pointing directions of these multiple beams. With these systems, each beam has a separate set of electronics associated with each element to process the various signals, including multiple phase shifters and other associated processing circuitry. These systems, therefore, suffer from significant drawbacks. Specifically, these tracking antennas are relatively expensive because of the multiple sets of electronics and are bulky because of the size required to house the electronics.

The present invention has recognized these drawbacks and provides an antenna 10 having a rotating plate 16 for mechanically scanning for wave signals in azimuth. The rotating plate 16 includes a plurality of radiation elements 18 positioned thereon for electronically scanning for wave signals in elevation. Each of the radiation elements 18 is in communication with a single multiplexer 44, which consolidates the wave signals received at each of the radiation elements to an analog bit stream. Thereafter, the analog bit stream is converted to a digital bit stream by an analog to digital converter 50. The digital bit stream is then transferred to a multiple beamforming device 54 which forms multiple digital beams. The digital

beams are converted to information signals such that the antenna 10 can lock onto a second equatorial satellite in the constellation before locking off a first equatorial satellite.

VI. Issues

The following issues are presented in this appeal, each of which correspond directly to the Examiner's final grounds for rejection and the Final Office Action, dated June 21, 2002:

Whether claims 1, 4, 5, 7-9, 11, 13-18, 21-22, and 25-37 are patentable under 35 U.S.C. § 103(a) over either one of *Richards et al.* or *Karlsson* et al. in view of either one of *Chiba et al.* or *Suzuki et al.* and further in view of *Chang et al.*

Whether claims 2, 3, 10, 12, 19, 20, and 23-24 are patentable under 35 U.S.C. § 103(a) over the combined prior art above as applied to the claims set forth above and further in view of *Ajioka* and *Barrett et al.*

VII. Grouping of Claims

The rejected claims have been grouped together in each of their rejections. The Appellant states, however, that each of the rejected claims stands on its own recitation and is separately patentable for the reasons set forth in detail below.

VIII. Argument

A. THE REJECTION OF CLAIMS 1, 4-9, 11, 13-18, 21-22 AND 25-37 UNDER 35 U.S.C. § 103(a)

Claims 1, 4-9, 11, 13-18, 21-22, and 25-37 stand finally rejected under 35 U.S.C. §103(a) as obvious over either *Richards et al.* or *Karlsson et al.* in view of either one of *Chiba et al.* or *Suzuki et al.* and further in view of *Chang et al.* Generally, claims 1, 4-9, 11, 13-18, 21-22, and 25-37 are similar in basic scope and thus the following arguments apply equally to the stated claims.

Claims 1, 7 and 21 are similar apparatus claims and will therefore be argued together. Claims 1, 7, and 21 are directed toward an antenna for communication with an equatorial satellite constellation having a rotating plate for mechanically scanning for wave signals in azimuth, a plurality of radiation elements positioned on the rotating plate for receiving incoming waves, and apparatus, such as a multiplexer, for consolidating all the individual wave signals received at each of the plurality of radiation elements and outputting an analog bit stream, and circuitry for forming multiple digital beams from the analog bit stream. These elements allow the antenna to lock onto a second equatorial satellite in the constellation before locking off a first equatorial satellite. Claims 1 and 7 further recite a digital receiver for processing the digital beams.

Claim 1 requires that the rotating plate be circular in shape. Further, claim 7 requires apparatus for positioning the radiation elements such that a wavefront will be in alignment with a major axis of the plurality of radiation elements. Additionally, claim 21 also requires that the elongated radiation elements have a major axis and a minor axis.

As the Examiner recognized, with respect to claims 1, 7, and 21 both *Richards et al.* and *Karlsson et al.* fail to teach the use of a digital beamformer. (February 1, 2002 Office Action p. 2) These references thus also fail to teach at least the following (1) a multiplexer associated with each of the plurality of radiation elements and (2) an analog to digital converter. Moreover, with respect to claims 1 and 7, *Richards et al.* and *Karlsson et al.* similarly fail to teach the use of a digital receiver for converting the digital beams into an information signal. These differences are significant in that applicants' claimed invention scans for wave signals and then based on the received wave signals converts them into information

streams. From this information, the antenna can determine where the various satellites in the equatorial satellite constellation are located for purposes of establishing communication therewith.

Specifically, with respect to *Richards et al.*, this reference fails to disclose any details regarding its beamforming. In fact, there is no teaching or suggestion in *Richards et al.* to utilize digital beamforming techniques or a digital beamformer. The Examiner's support for the rejections is based on clear legal error. First, the Examiner states that "the applicants have not shown how the combination fails to suggest the claimed subject matter." However, it is the Examiner's burden to prove a *prima facie* case of obviousness by showing that some suggestion or motivation to combine exits in the relied on references. In re Dembiczak, 175 F.3d 994, 999 (Fed. Cir. 1999). It is not the Applicant's burden to demonstrate the absence of some suggestion or motivation to combine the relied on references. Moreover, the Examiner's statement that "the combination of references is deemed to suggest the claimed subject matter" constitutes improper hindsight reconstruction. To sustain such an obviousness rejection, there must be some teaching or suggestion in the reference to combine the aspects of the other reference. Ruiz v. A. B. Chance, 234 F.3d 654, 665 (Fed. Cir. 2000). Here, no such teaching exists, and thus independent claims 1 and 7, which each require digital beamforming, are all submitted to be allowable over the *Richards, et al.* reference for this reason alone.

Moreover, *Richards et al.* fails to teach a rotating plate -- let alone a rotating circular plate. Instead, *Richards et al.* teaches a two-dimensional position 11 that "can mechanically position or align antenna 10 in azimuth in the first dimension and tilt in roll in the second dimension." (Col 2., lines 63 – 65) *Richards et al.* thus teaches mechanical positions in two dimensions, instead of a rotating plate.

Similarly, *Karlsson et al.* fails to disclose any details about digital beamforming. Moreover, *Karlsson et al.* specifically teaches away from using digital beamforming to receive and convert wave signals into information streams by which the location of satellites in the constellation is determined. At column 7, lines 41-45, *Karlsson et al.* states:

> the circuitry of the radio communications system of which the antenna 11 forms a part, is told by a beacon signal from the satellite system the precise position at which the next coming satellite will appear on the horizon.

Thus, the radiation elements themselves do not convert the received wave signals into information streams to determine the positions of the satellites, as required by the claims of applicants' invention. As such, each of independent claims 1, 7 and 21 are also allowable over the *Karlsson et al.* reference for this reason alone. Moreover, *Karlsson et al.* does not teach a rotating plate or a rotating circular plate upon which elongated radiating elements having a major axis and a minor axis are disposed.

Claims 13 and 30 are similar claims, which require a method for communicating with an equatorial satellite constellation, including providing a plurality of radiation elements on the surface of an antenna, rotating the antenna such that a wavefront of a plurality of individual wave signals is in alignment with a major axis of the radiation elements, consolidating the plurality of wave signals into a single bit stream, forming multiple beams from the single analog signal, and transmitting the multiple beams to a plurality of satellites in the equatorial satellite constellation.

Neither *Richards et al.* or *Karlsson et al.* teach <u>rotating</u> an antenna such that a wavefront of a plurality of individual wave signals is in alignment with a major axis of

the radiation elements. As discussed above, *Richards et al.* does not teach a rotating plate. Richards et al. describe mechanically moving a rectangular plate through two dimensions (azimuth and roll). *Karlsson et al.* similarly teaches mechanically moving a square plate. Moreover, *Karlsson et al.* does not teach moving an antenna such that a wavefront of a plurality of individual wave signals is in alignment with a major axis of the radiation elements. It is thus submitted that claims 13 and 30 are allowable for this reason alone.

Further, neither *Richards et al.* or *Karlsson et al.* teach consolidating a plurality of wave signals into a single bit stream, forming multiple beams from the single analog signal, and transmitting the multiple beams to a plurality of satellites in the constellation. It is thus submitted that claims 13 and 30 are allowable for this additional reason.

Claims 21 and 37 are also submitted to be allowable over each of *Richards et al.* and *Karlsson et al.* for the additional reason that each of these claims requires a plurality of elongated radiation elements positioned on the rotating circular plate for electronically scanning for wave signals and elevation. Initially, neither *Richards et al.* nor *Karlsson et al.* teach a rotating circular plate upon which radiation elements are mounted, as discussed above. Further, neither *Richards et al.* or *Karlsson et al.* teach a plurality of elongated radiation elements -- let alone a plurality of radiation elements -- each having a multiplexer associated therewith. Thus, it is submitted that claims 21 and 37 are allowable for this additional reason.

Claim 37 further requires that the plurality of elongated radiation elements are positioned on the rotating plate such that they are parallel to one another. Again, this is not taught or suggested by either *Richards et al.* or *Karlsson et al.* Thus, it is

submitted that these claims are allowable over these references for this additional reason.

Further, with respect to *Karlsson et al.*, claims 1, 7 and 13 all require that the antenna is able to lock onto a second equatorial satellite in the constellation before locking off a first equatorial satellite. The Examiner states that *Karlsson et al.* teaches this configuration. The applicants, however disagree. *Karlsson et al.* teaches calculating an estimated time and location when a second satellite will come into a field of view and then thereafter calculating an estimated vector such that one beam will move from the first satellite to the second satellite at the estimated handoff time when it is determined that the first and second satellites are both in the field of view. In other words, *Karlsson et al.* teaches moving the beam from one satellite to a second satellite but not multiple beams each in communication with a pair of satellites. This is contrary to applicants' claimed invention which has multiple beams with one beam in communication with a first satellite and after the location of a second satellite has been determined based on received waveforms a second beam connects to the second satellite regardless of the estimated time or position. It is thus submitted that claims 1, 7 and 13 are allowable for this additional reason.

Claim 4 is also believed to be independently patentable since claim 4 requires that the circuitry for forming multiple digital beams does so through FFT techniques. The cited references do not teach or suggest this in association with the recitations of claim 1.

Claim 5 is also believed to be independently patentable since claim 5 requires that the antenna may be utilized on a mobile vehicle. The cited references do not teach or suggest this in association with the recitations of claim 1.

Claim 8 is also believed to be independently patentable since claim 8 further requires that the device for forming multiple digital beam forms utilize a FFT technique. The cited references do not teach or suggest this in association with the recitations of claim 7.

Claim 9 is also believed to be independently patentable since claim 9 requires that the antenna transmit the multiple digital beams to a plurality of satellites in the equatorial satellite constellation. The cited references do not teach or suggest this in association with the recitations of claim 7.

Claim 11 is also believed to be independently patentable since claim 11 requires that the rotating plate is generally circular in shape. The cited references do not teach or suggest this in association with the recitations of claim 7.

Claim 14 is also believed to be independently patentable since claim 14 further requires converting the single analog signal to a digital bit stream and forming multiple digital beams from the digital bit stream. The cited references do not teach or suggest this in association with the recitations of claim 13.

Claim 15 is also believed to be independently patentable since claim 15 further requires utilizing FFT techniques to form the multiple digital beams to provide for satellite retrodirectivity. The cited references do not teach or suggest this in association with the recitations of claim 14.

Claim 16 is also believed to be independently patentable since claim 16 further requires processing the multiple digital beams prior to transmitting. The cited references do not teach or suggest this in association with the recitations of claim 14.

Claim 17 is also believed to be independently patentable since claim 17 requires that the plurality of radiation elements electronically scan for the wave

signals in elevation. The cited references do not teach or suggest this in association with the recitations of claim 14.

Claim 18 is also believed to be independently patentable since claim 18 requires that the antenna is comprised of a generally circular plate that rotates for scanning mechanically for the wave signals in azimuth. The cited references do not teach or suggest this in association with the recitations of claim 17.

Claim 22 is also believed to be independently patentable since claim 22 further requires a converter for converting the first bit stream from an analog bit stream to a digital bit stream. The cited references do not teach or suggest this in association with the recitations of claim 21.

Claim 25 is also believed to be independently patentable since claim 25 requires that the antenna be utilized on a mobile vehicle. The cited references do not teach or suggest this in association with the recitations of claim 21.

Claim 26 is also believed to be independently patentable since claim 26 requires that the apparatus for consolidating the wave signals is a multiplexer. The cited references do not teach or suggest this in association with the recitations of claim 21.

Claim 27 is also believed to be independently patentable since claim 27 requires that the multiplexer is a code division multiplexer. The cited references do not teach or suggest this in association with the recitations of claim 26.

Claim 28 is also believed to be independently patentable since claim 28 requires that the antenna is configured with a low profile. The cited references do not teach or suggest this in association with the recitations of claim 21.

Claim 29 is also believed to be independently patentable since claim 29 requires that antenna is in communication with a commercial satellite terminal. The

cited references do not teach or suggest this in association with the recitations of claim 21.

Claim 31 is also believed to be independently patentable since claim 31 further requires mechanically scanning a field of view for the wave signals in azimuth. The cited references do not teach or suggest this in association with the recitations of claim 30.

Claim 32 is also believed to be independently patentable since claim 32 further requires electronically scanning the field of view for the wave signals in elevation. The cited references do not teach or suggest this in association with the recitations of claim 31.

Claim 33 is also believed to be independently patentable since claim 33 further requires converting the single signal to a digital bit stream and forming multiple digital beam forms from the digital bit stream. The cited references do not teach or suggest this in association with the recitations of claim 30.

Claim 34 is also believed to be independently patentable since claim 34 further requires utilizing FFT techniques to form the multiple digital beam forms to provide for satellite retrodirectivity. The cited references do not teach or suggest this in association with the recitations of claim 33.

Claim 35 is also believed to be independently patentable since claim 35 further requires providing seamless handover from one satellite to another without interruption. The cited references do not teach or suggest this in association with the recitations of claim 31.

Claim 36 is also believed to be independently patentable since claim 36 further requires monitoring signal strength from adjacent received individual wave signals in order to track other satellites in the equatorial satellite constellation. The

cited references do not teach or suggest this in association with the recitations of claim 31.

B. THE REJECTION OF CLAIMS 2, 3, 10, 12, 19, 20, and 23-24 UNDER 35 U.S.C. § 103(a)

Claims 2, 3, 10, 12, 19, 20, and 23-24 stand finally rejected under 35 U.S.C. §103(a) as obvious over the combined prior art set forth above as applied to the claims set forth above and further in view of *Ajioka* and *Barrett et al.* Claims 2, 3, 10, 12, 19, 20, and 23-24 are dependent claims, which depend from a respective one of the independent claims set forth above. Thus, the argument set forth above in connection with any claim from which one of these claims depends applies equally to the stated claims. Additionally, the Examiner states that the combined prior art "fails to specify the electronically scanned antenna array as comprising cross-slotted waveguides each including a septum". (February 1, 2002 Office Action, p. 4.)

Claim 2 is also believed to be independently patentable since claim 2 requires that the plurality of radiation elements are parallel cross-slotted waveguides. The cited references do not teach or suggest this in association with the recitations of claim 1.

Claim 3 is also believed to be independently patentable since claim 3 requires that the plurality of radiation elements include a slotted septum therein. The cited references do not teach or suggest this in association with the recitations of claim 2.

Claim 10 is also believed to be independently patentable since claim 10 requires that the plurality of radiation elements are interdigitally spaced slotted wave guides. The cited references do not teach or suggest this in association with the recitations of claim 8.

Claim 12 is also believed to be independently patentable since claim 12 requires that the plurality of radiation elements include a slotted septum therein. The cited references do not teach or suggest this in association with the recitations of claim 11.

Claim 19 is also believed to be independently patentable since claim 19 further requires that the plurality of radiation elements are cross-slotted waveguides. The cited references do not teach or suggest this in association with the recitations of claim 18.

Claim 20 is also believed to be independently patentable since claim 20 requires that the plurality of cross-slotted waveguides are parallel and interdigitally spaced with respect to each other. The cited references do not teach or suggest this in association with the recitations of claim 19.

Claim 23 is also believed to be independently patentable since claim 23 requires that each of the plurality of elongated radiation elements are cross-slotted waveguides, which are aligned parallel to one another on the antenna. The cited references do not teach or suggest this in association with the recitations of claim 21.

Claim 24 is also believed to be independently patentable since claim 24 requires that each of the plurality of radiation elements include a slotted septum therein. The cited references do not teach or suggest this in association with the recitations of claim 23.

IX. Appendix

A copy of each of the claims involved in this appeal, namely claims 1-5 and 7-37, is attached hereto as Appendix A.

X. Conclusion

For the foregoing reasons, Applicant respectfully requests that the Board direct the Examiner in charge of this examination to withdraw his rejections and pass this case to issuance.

Respectfully submitted,

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APPENDIX A

1. An antenna for communication with an equatorial satellite constellation, the antenna being for use on a commercial satellite terminal, comprising:

a generally circular rotating plate for mechanically scanning for wave signals in the azimuth direction;

a plurality of radiation elements positioned on said circular plate for electronically scanning for wave signals in elevation; and

a multiplexer associated with each of said plurality of radiation elements for consolidating the individual wave signals received at each of said plurality of radiation elements to an analog bit stream;

an analog to digital converter for converting said analog bit stream to a digital bit stream;

circuitry for forming multiple digital beams from said digital bit stream; and

a digital receiver for converting said digital beams into an information signal;

wherein the antenna is able to lock onto a second equatorial satellite in the constellation before locking off a first equatorial satellite.

2. The antenna of claim 1, wherein said plurality of radiation elements are a plurality of parallel cross-slotted waveguides.

3. The antenna of claim 2, wherein each of said plurality of parallel cross-slotted waveguides includes a slotted septum therein.

4. The antenna of claim 1, wherein said circuitry for forming multiple digital beams does so through FFT techniques.

5. The antenna of claim 1, wherein said antenna may be utilized on a mobile vehicle.

7. A phased array antenna for communication with an equatorial satellite constellation, comprising:

a rotating plate for mechanically scanning for a wavefront of wave signals in an azimuth direction;

a plurality of radiation elements positioned on said rotating plate for receiving a plurality of individual waves;

apparatus for positioning said radiation elements such that a wavefront of an intended signal will be in alignment with a major axis of said plurality of radiation elements;

a multiplexer device being in communication with each of said plurality of radiation elements for converting said plurality of received individual waves into an analog bit stream;

an analog to digital converter for converting said analog bit stream to a digital bit stream;

a device for forming multiple digital beams from said digital bit stream; and

a digital receiver for processing said multiple digital beams;

wherein the antenna is able to lock onto a second equatorial satellite in

the constellation before locking off a first equatorial satellite.

8. The antenna of claim 7, wherein said device for forming multiple digital beam forms utilizes a FFT technique to provide for retrodirectivity.

9. The antenna of claim 7, wherein said antenna transmits said multiple digital beams to a plurality of satellites in the equatorial satellite constellation.

10. The antenna of claim 8, wherein said plurality of radiation elements are a plurality of interdigitally spaced slotted wave guides.

11. The antenna of claim 7, wherein said rotating plate is generally circular in shape.

12. The antenna of claim 11, wherein each of said plurality of interdigitally spaced slotted waveguides includes a slotted septum therein.

13. A method for forming multiple beams at a commercial satellite antenna comprising:

providing a plurality of radiation elements on a surface of said commercial satellite antenna for receiving a plurality of individual wave signals;

rotating said plurality of radiation elements such that a wavefront of said plurality of individual wave signals is in alignment with a major axis of said plurality of radiation elements;

consolidating said plurality of wave signals into a single analog signal;

forming multiple beams from said single analog signal; and

transmitting said multiple beams to a plurality of satellites in an equatorial satellite constellation;

whereby the antenna is able to lock onto a second equatorial satellite in the constellation before locking off a first equatorial satellite.

14. The method of claim 13, further comprising:

converting said single analog signal to a digital bit stream; and

forming multiple digital beams from said digital bit stream

15 The method of claim 14, further comprising:

utilizing FFT techniques to form said multiple digital beams to provide for satellite retrodirectivity.

16. The method of claim 14, further comprising:

processing said multiple digital beams prior to transmitting.

17. The method of claim 14, wherein said plurality of radiation elements electronically scan for said wave signals in elevation.

18. The method of claim 17, wherein said surface of said antenna is comprised of a generally circular plate that rotates for scanning mechanically for said wave signals in azimuth.

19. The method of claim 18, wherein said plurality of radiation

elements are a plurality of cross-slotted waveguides.

20. The method of claim 19, wherein said plurality of cross-slotted waveguides are parallel and interdigitally spaced with respect to each other.

21. A phased array antenna for communication with an equatorial satellite constellation, comprising:

a rotating plate for electronically scanning for a wavefront of wave signals in elevation and for mechanically scanning for said wavefront of wave signals in an azimuth direction;

a plurality of elongated radiation elements positioned on said rotating plate for receiving a plurality of individual waves, each of said plurality of radiation elements having a major axis and a minor axis;

apparatus associated with each of said plurality of radiation elements for consolidating the wave signals received at each of said plurality of radiation elements into a first bit stream; and

a multiple beam former for forming multiple beams from said first bit stream.

22. The antenna of Claim 21, further comprising:

a converter for converting said first bit stream from an analog bit stream to a digital bit stream, which digital bit stream is received by said multiple beam former.

23. The antenna of Claim 21, wherein each of said plurality of elongated radiation elements are cross-slotted waveguides, which are aligned

parallel to one another on the antenna.

24. The antenna of Claim 23, wherein each of said plurality of radiation elements includes a slotted septum therein.

25. The antenna of Claim 21, wherein the antenna may be utilized on a mobile vehicle.

26. The antenna of Claim 21, wherein said apparatus for consolidating the wave signals is a multiplexer.

27. The antenna of Claim 26, wherein said multiplexer is a code division multiplexer.

28. The antenna of Claim 21, wherein the antenna is configured with a low profile.

29. The antenna of Claim 21, wherein the antenna is in communication with a commercial satellite terminal.

30. A method of communicating with an equatorial satellite constellation, comprising:

providing a plurality of generally parallel radiation elements on a surface of a commercial satellite antenna;

rotating said satellite antenna such that a wavefront of a plurality of

individual wave signals is in alignment with a major axis of said plurality of radiation elements;

consolidating said plurality of wave signals into a single bit stream;

forming multiple beams from said single bit stream; and

transmitting said multiple beams to a plurality of satellites in the equatorial satellite constellation.

31. The method of Claim 30, further comprising:

mechanically scanning a field of view for said wave signals in azimuth.

32. The method of Claim 31, further comprising:

electronically scanning said field of view for said wave signals in elevation.

33. The method of Claim 30, further comprising:

converting said single signal to a digital bit stream; and

forming multiple digital beam forms from said digital bit stream.

34. The method of Claim 33, further comprising:

utilizing FFT techniques to form said multiple digital beam forms to provide for satellite retrodirectivity.

35. The method of Claim 31, further comprising:

providing seamless handover from one satellite to another without interruption.

36. The method of Claim 31, further comprising:

monitoring signal strength from adjacent received individual wave signals in order to track other satellites in the equatorial satellite constellation.

37. A commercial satellite terminal for communication with an equatorial satellite constellation comprising:

an antenna including,

a generally circular rotating plate for mechanically scanning for wave signals in the azimuth direction;

a plurality of elongated radiation elements positioned generally parallel to one another on said circular plate for electronically scanning for wave signals in elevation;

a multiplexer associated with each of said plurality of radiation elements for consolidating the individual wave signals received at each of said plurality of radiation elements to a first bit stream; and

a multiple beam former for forming multiple beams from said first bit stream.